Glaciation and Drainage Changes in Allen County, Indiana

by

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Rex M. Potterf, Editor

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PREFACE

Scope of Investigation

The purpose of this project is to analyze the drainage changes that have taken place in Allen County and to determine their relationship to the present drainage pattern. Allen County lends itself well to this type of study. The changes are major and are of significance to the drainage of all northeastern Indiana. Since glaciation was responsible for nearly all of these changes, glacial events have been reconstructed to illustrate the ways in which the changes were accomplished.

Location of Area

Allen County is located in the northeastern part of Indiana. Fort Wayne, the county seat is 115 miles northeast of Indianapolis. The county is approximately 28 miles long and 24 miles wide, covering an area of 664 square miles. It is bounded on the south by Adams and Wells Counties, on the west by Huntington and Whitley Counties, on the north by Noble and DeKalb Counties, and on the east by Paulding and Defiance Counties, Ohio.

The northern third of the county lies within the Steuben Morainal Lake Region, the east-central third comprises the entire Maumee Lacustrine Section of the same region, and the southern third is part of the Tipton Till Plain. Relative to the physiography of the United States, the southern third of the county is in the

Till Plains Section of the Central Lowland Province, and the remainder is in the Eastern Lake Section of the same province.

Physically, Allen County is part of the Wabash-Erie Region, a shallow trough which extends from Lake Erie southwest to the Illinois border. The trough is 200 miles long, 100 miles wide, and 200 feet deep. Allen County lies exactly in the middle of the major axis, and from a point just west of Fort Wayne the bottom of the trough slopes gently toward either end.

Previous Work

Grove Karl Gilbert was one of the first to recognize the effects of glaciation upon the drainage of the area in his report on The Surface Geology of the Maumee Valley for the Ohio Geological Survey (1871-1873). Charles R. Dryer, in the 16th Annual Report of the Indiana Department of Geology and Natural History (1889), described many of the physiographic features of the county. Frank Leverett wrote two classical works, The Pleistocene of Indiana and Michigan (1915) and The Glacial Formations and Features of the Erie and Ohio Basins (1902), that included sections on Allen County. Others listed in the Bibliography dealt marginally with the drainage of the area. Their reports however are primarily devoted to the composition and structure of the moraines rather than to their effect on drainage.

Acknowledgments

Dr. Albert Jackman, Department of Geography, Western Michigan University supervised this investigation. The United States Geological Survey supplied topographic maps of the 7 1/2-Minute Series. William J. Wayne of the Indiana Geological Survey furnished

pre-Pleistocene topographic maps. A valuable drainage map prepared by Dr. Merle Parvis of Purdue University aided extensively. The United States Department of Agriculture made available aerial photographs.

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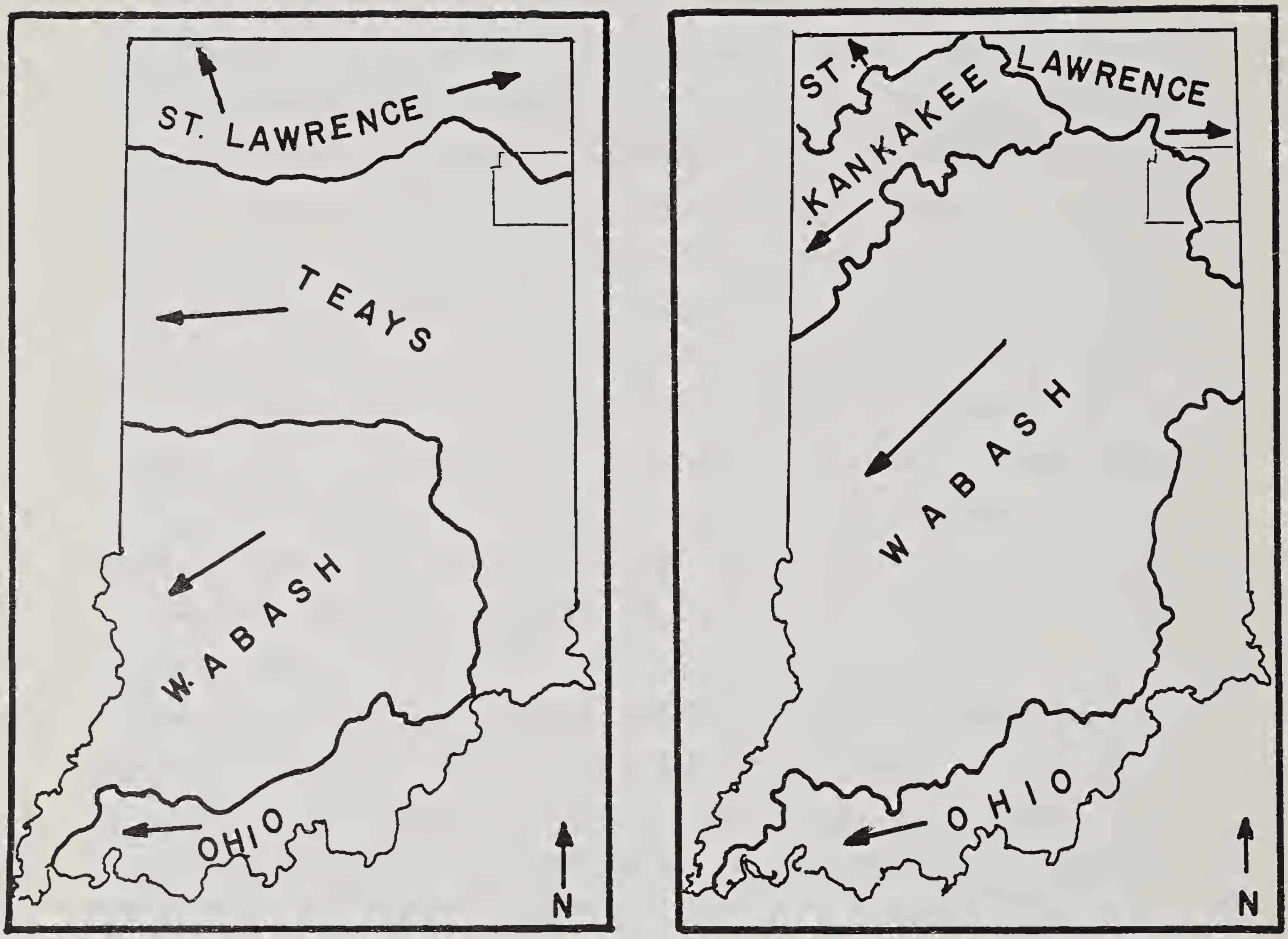
INTRODUCTION

The drainage of Allen County has been considerably altered as a result of glaciation, and these changes can be examined in order of their occurrence. The preglacial topography, buried under a thick layer of drift, produced a landscape vastly different from that which had preceded it. The streams that developed on the new surface were greatly affected by the presence of the moraines. The first significant change associated with the withdrawal of ice from the area saw the formation of the Wabash Moraine and subsequent diversion of Cedar Creek. After the formation of the Fort Wayne Moraine, meltwater backed behind that ridge created Lake Maumee. The latter eventually overflowed into the Wabash Sluiceway. After the torrent cessed and the lake level lowered the Maumee River reversed its direction of flow. Some changes are still in process, but their nature clearly reflects the influence of glaciation. The following paper deals in greater detail with these changes, both glacial and postglacial, and the events responsible for them.

I. PRE-PLEISTOCENE DRAINAGE

Five major river systems drained Pre-Pleistocene Indiana. Fig. 1 shows the largest of these, the Teays Drainage Basin, which extended across central Indiana. The Wabash and its tributaries, the White and the Ohio, drained the southwestern third of the state. The Whitewater, which emptied into the Gulf of Mexico via the Mississippi River was the main stream in southeastern Indiana. Because of the drainage divide that crossed Indiana from Newton and Jasper Counties in the western part of the state to Allen County on the eastern side, streams in northern Indiana entered the St. Lawrence Drainageway to the Atlantic.[1]

Allen County, shown in Fig. 2, lies almost astride this bedrock divide, between drainage southward into the ancient Teays River system and drainage northward into the St. Lawrence. Those streams that drained into the Teays cut valleys in the bedrock surface of Devonian and Lower Mississippian Shales, but these streams were not as deeply entrenched below the upland as were tributaries nearer the master drainage line.[2] The Eel River follows the course of one of these bedrock tributaries of the Teays, the Metea Valley, which probably headed in western Allen County (Fig. 2).[3] Some drainage northwest to the present Butler Valley bore some similarity of direction to the present course of the Maumee River (Fig. 2).[4] These similarities are entirely coincidental. They exist only because of the presence of a drainage divide in Allen County at both times. Otherwise, the drainage differs completely from the earlier pattern.



After Thornbury

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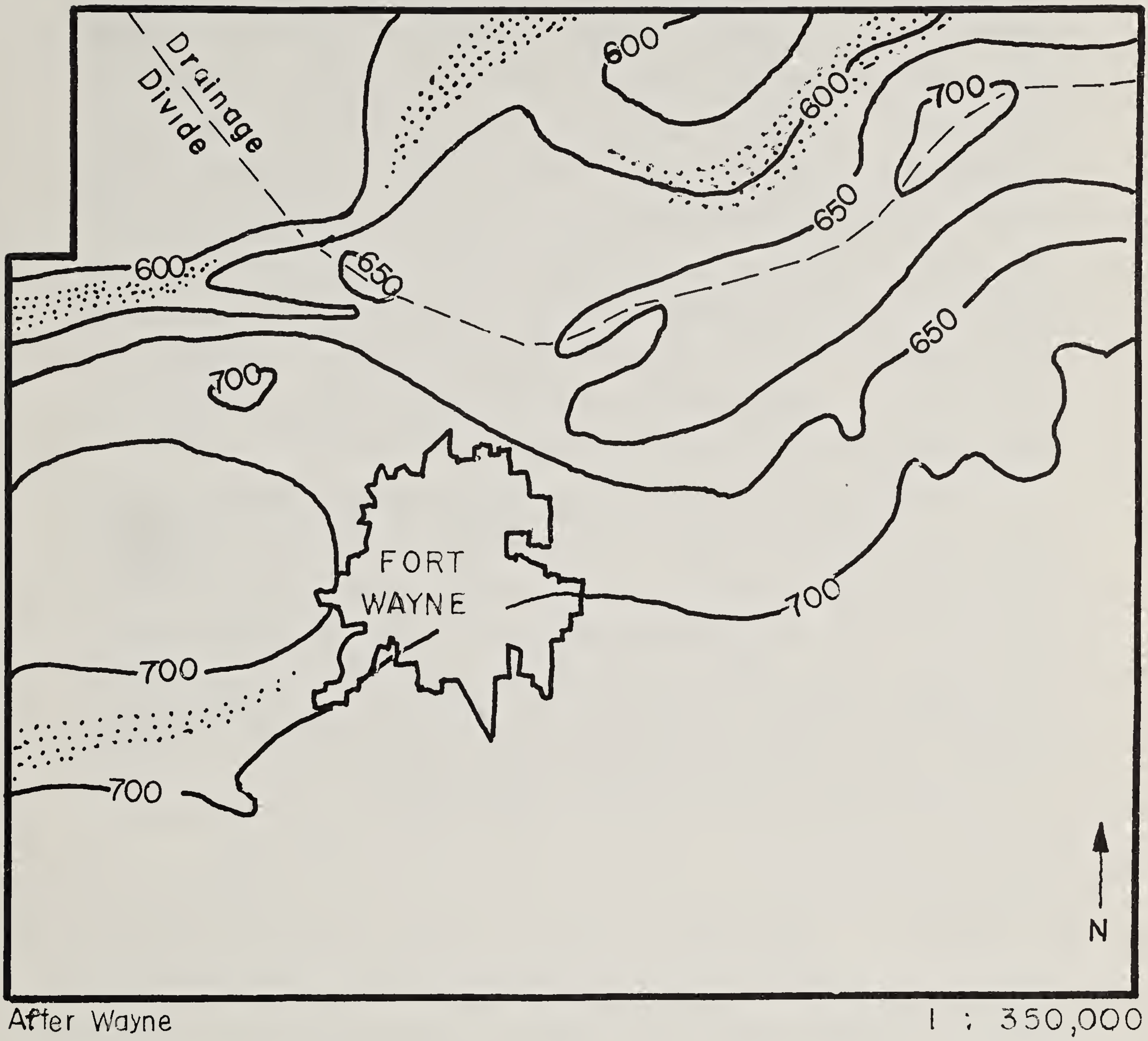
A. Preglacial.

B. Present.

Fig. 1 -- Drainage Basins Of Indiana



PREGLACIAL VALLEY

Fig.2--Pre-Glacial Topography Of Allen Co.

Most of the erosion that shaped this surface probably occurred prior to the Nebraskan Glaciation. The major disruption of the preglacial drainage can be attributed to the Kansan Glaciation. At that time the preglacial drainage was modified to divert the Upper Teays drainage to the south and to add the Teays drainage in central Indiana to the preglacial Wabash (Fig. 1).[5] The Illinoisan Glaciation further obscured and closed portions of the Teays Valley, although some discontinuous segments still served as drainage lines.[6] The Teays continued partially as a drainage line until Wisconsin time when it was completely buried and abandoned. The modern Wabash, which closely follows the old stream course in some places has exhumed parts of the Teays Valley.

Preglacial Allen County probably resembled in relief the unglaciated present day southern Indiana. That surface configuration was greatly altered, however, by the repeated deposition of glacial debris. These glaciations obliterated preglacial drainage lines in the area and the superposed new stream courses across the buried bedrock topography.

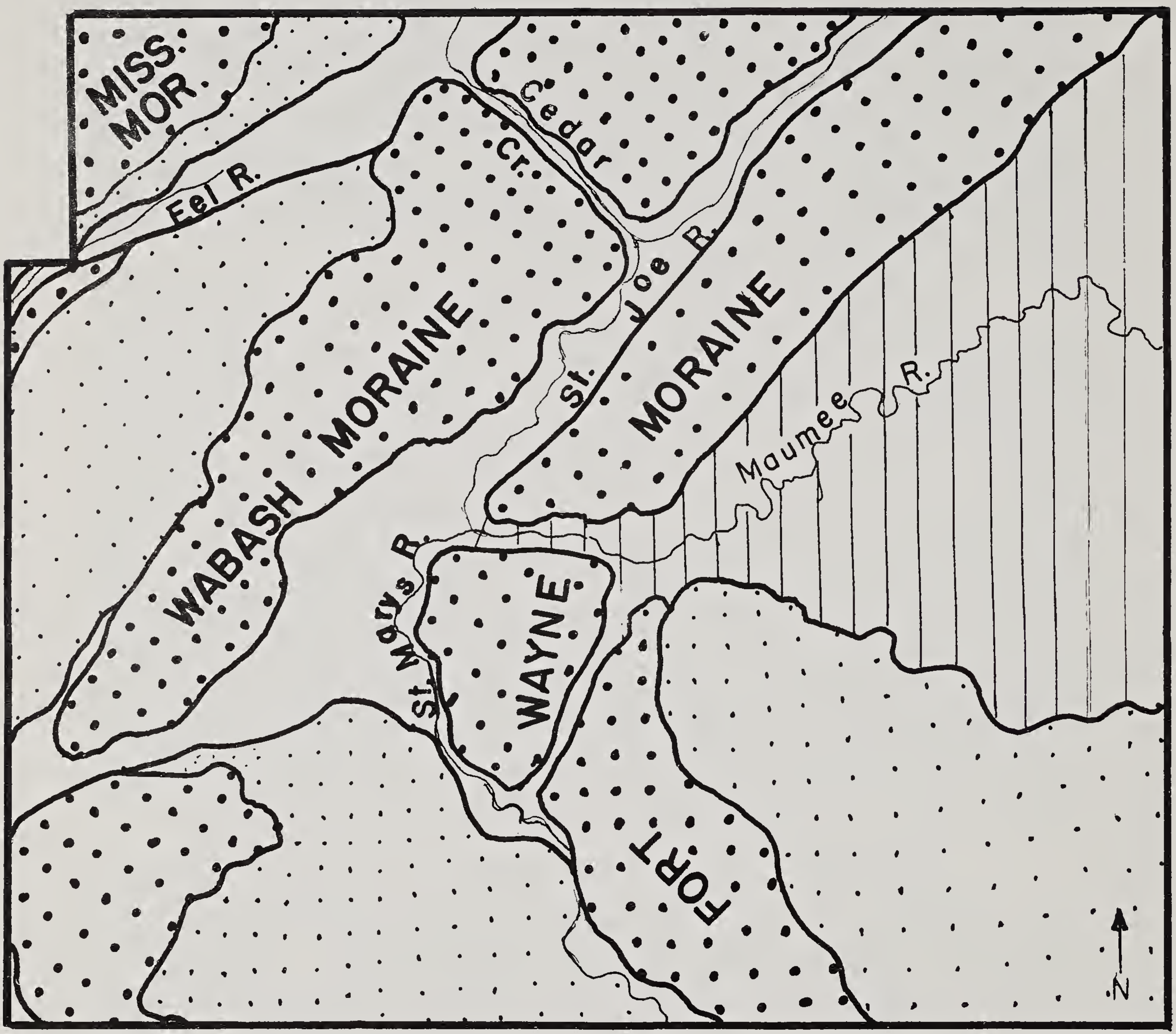
II. PLEISTOCENE MORAINES AND THEIR EFFECT ON DRAINAGE

As the glaciers retreated, much debris remained as till plain which completely buried the preglacial erosion surface of Allen County. The flood of escaping meltwater from the receding glaciers first spread over this till plain but was later concentrated along certain lines of discharge. Once these waters formed definite channels, erosion sufficed to cut valleys in the thick mantle of drift.

Control of stream courses and stream deflections are largely attributable to the presence of the moraines. In Allen County the position of the recessional moraines primarily determined the drainage lines. A series of these crescentic ridges transversely crosses the Wabash-Erie Trough, in which Allen County is located midway. As Fig. 3 indicates, the moraines are convex and lie parallel to the southwest shore of Lake Erie. Since these ridges lie across the gradient of the trough, the principal streams that flow from the margins of the trough to the axial channel closely follow the western faces of the moraines.

Possibly because of sudden changes in climate the melting of the Erie Lobe during the Woodfordian Substage (Wisconsin) lacked uniformity. Periods of rapid melting alternated with periods when the terminus was stationary. Each of these halting places marks a moraine (Fig. 3).

The glacial retreat was slow and even in the region southwest of Allen County. There were, however, three periodic retreats of fifteen miles. Each resulted in a moraine and the establishment of drainage channels along the outer faces. The courses of nearly all the major streams in the county are parallel because of the symmetry of the moraines. The Maumee is the only river which violated this symmetry;



After Wayne

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MORAINE

TILL PLAIN

GLACIAL LAKE

SLUICEWAY

FIG. 3--Glacial Geography Of Allen County

it did not come into existence until the Fort Wayne Moraine was breached and the waters of the St. Joseph and St. Mary's Rivers were pirated from the Wabash.

The retreating glaciers left behind on the northern border of the county drift nearly 250 feet thick which decreases to approximately 50 feet on the southern border.[7] Except for the gravel plains in the northeastern part of the county and along the glacial sluiceways, the till is composed of clay. Northwestern and southeastern Allen County includes beds of water-bearing gravel within the till at a depth of twenty to forty feet.[8] This has permitted several artesian wells east of New Haven on the lacustrine plain.

Allen County is traversed by three distinct morainic systems, shown in Fig. 3. The Mississinewa Moraine covers a few square miles in the northwestern part of the county. The Wabash Moraine extends from the southwestern corner of the county to the central part of the northern boundary. The Fort Wayne Moraine curves from the south-central, through the central, to the northeast. Minor ridges in the area, especially near Monroeville, appear to be morainic. Some of the ridges east of Fort Wayne are clearly lake beaches, such as the Blanchard and Van Wert Ridges, and are not morainic.

These morainic areas are rolling and hummocky, some having a subdued "swag and swell" topography.[9] The inter-morainic are gently undulating. The maximum local relief approximates 100 feet and is developed entirely within the till of the moraine.

The Fort Wayne Moraine is not very spectacular in terms of relief. In fact it is so low (twenty-five to fifty feet) and so wide (four to eight miles) that its presence long went undetected. The unusual drainage of the region provided clues to the existence of the moraine. Grove Karl Gilbert noticed that the course of the St. Mary's River was to the northwest and that

while tributaries flowed northeast into it from the left bank, streams on the right bank flowed northeast into the Auglaize River. Gilbert found that there was a continuous ridge that ran obliquely across the slopes of the county, following the east banks of these rivers and determining their courses. Gilbert said:

> I conceive that this ridge is the superficial representation of a terminal glacial moraine that rests directly on the rock bed and is covered by a heavy sheet of Erie clay, a subsequent aqueous and ice-berg deposit.[10]

The control the ridge exerted on drainage led Winchell to compare it to a "dead wave on the surface of the ocean, hardly perceptible to the naked eye on account of its smoothness, but revealed by its effect upon everything that encounters it."[11]

The Fort Wayne Moraine has been deeply channeled by water near the headwaters of the Maumee (Fig. 3). Most important of these channels is the Fort Wayne Outlet of Lake Maumee, which had its passage through the moraine, leaving a gap nearly one mile wide. Cedar Creek has also channeled through the moraine. Most of the streams, however, are in shallow trenches and flow away from the moraine or along side it.

Fine-textured drainage patterns, though sometimes inconsistent, outline the moraines of the county. Most of the major streams cross the morainic areas, where the drainage has been concentrated. Those streams in the flat intermorainic areas are widely-spaced and produce a pattern of very coarse texture. Crests of the moraines define watershed divides in the county, and because of the relief some local drainage basins have developed in the morainic areas.

III. EEL SLUICEWAY

When the ice sheet occupied Allen County, tremendous quantities of meltwater were released. While the Wabash Sluiceway carried away much of this flow the Eel Sluiceway also carried a large share. The Eel Sluiceway is significant in Allen County because a major drainage change is associated with it.

The Eel Sluiceway was formed when Upper Cedar Creek, an ice marginal stream, united with what is now the Eel River (Fig. 3). While the Wabash Moraine was being constructed, a large volume of water flowed through this channel. Aboite and Eight-Mile Creeks functioned as minor sluiceways, adding their waters to that of the Eel Sluiceway. This rushing water deposited outwash (silt and sand) in some places along the sluiceway and eroded away the till cover in others.

Immediately after the formation of the Wabash Moraine, the diversion of Cedar Creek took place. Cedar Creek before the diversion formed an integral part of the Eel Sluiceway (Fig. 4a). From the northwestern edge of the ide lobe, the creek carried meltwater to the lower sluiceway. A proglacial stream which brought meltwater into the Eel Sluiceway from the ice sheet just beyond the moraine cut Cedar Creek in its lower course. The valley of the Eel Sluiceway eroded to an altitude of 835 feet, which is also the altitude of the present divide between Cedar Creek and Eel River.

Lower Cedar Creek carried a fine outwash to the Eel Sluiceway and deposited it downstream from its junction with the latter. The withdrawal of the ice front from the Wabash Moraine greatly reduced the amount of meltwater supplied to the headwaters of the sluiceway. The meltwater that had formerly crossed the moraine through Lower Cedar Creek then diverted

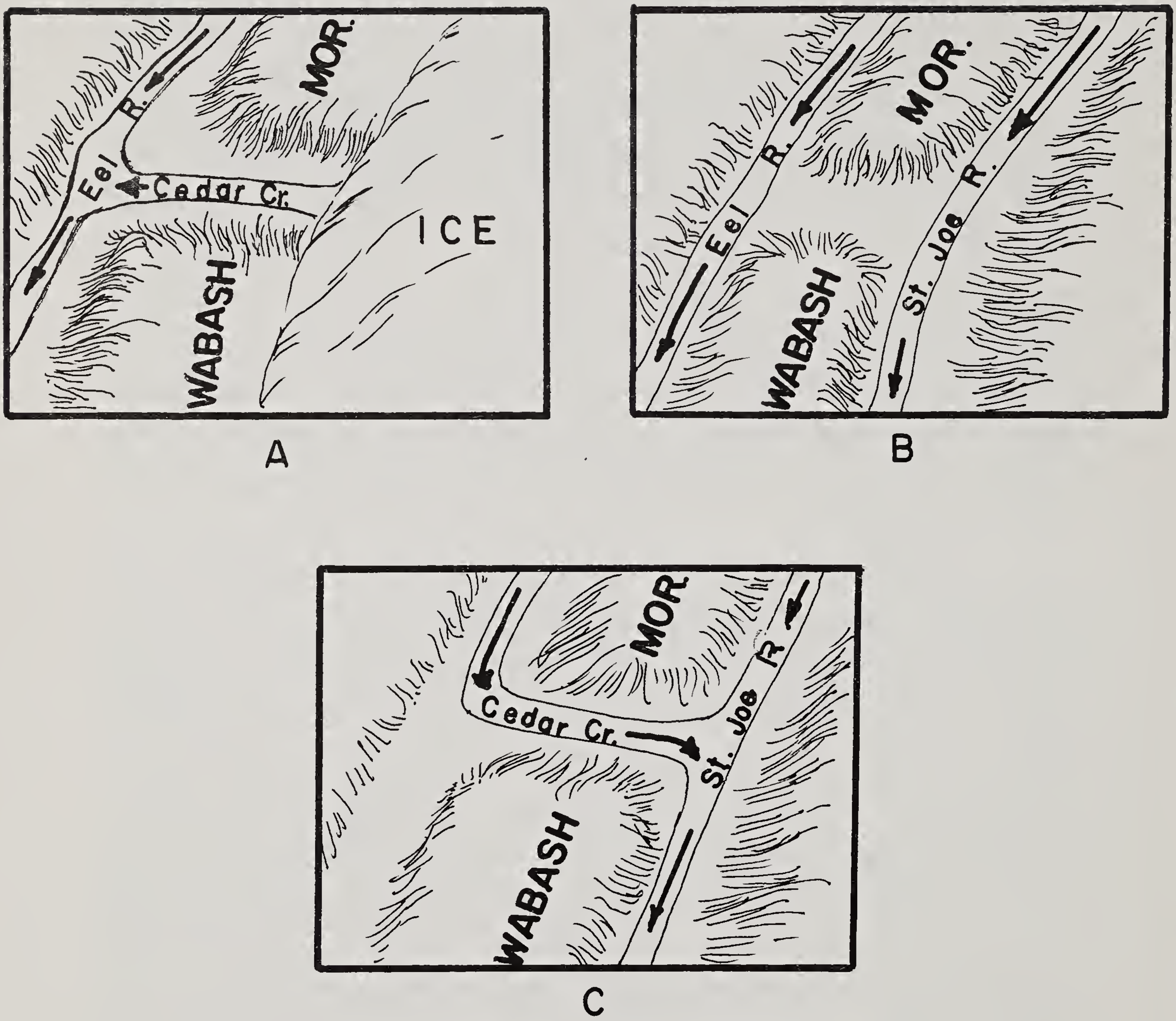


Fig. 4.-- Diversion Of Cedar Creek .

to the newly-formed St. Joseph River. The latter was an ice-marginal stream that possessed a bed lower than that of the sluiceway (Fig. 4b).

Because of the reduced discharge and the change in direction, the outwash that had been deposited below the junction of Lower Cedar Creek and the Eel Sluiceway remained uneroded. Instead these sediments acted as a divide between the Lower Eel Sluiceway and Upper Cedar Creek (formerly the Upper Eel Sluiceway) (Fig. 4c).

Thus the drainage from Upper Cedar Creek was channeled through Lower Cedar Creek into the St. Joseph River. In so doing, it carved a gorge nearly 1000 feet deep and 1000 feet wide. The Diversion of Cedar Creek marked the end of the Eel Sluiceway, which was deprived of its major tributary. After the sluiceway ceased to be active, the present drainage with its underfit streams began to develop.

IV. GLACIAL LAKE MAUMEE

Contemporary with the formation of the moraines by the melting ice, great quantities of water flowed away from the terminus (Fig. 5a). Much of this was probably in the form of braided streams which were concentrated along the main drainage line of the present St. Joseph and Wabash Rivers. These two rivers were connected at that time.

This drainage line to the southwest remained until the ice had retreated to a line immediately east of Fort Wayne. There the trough sloped back toward the ice, causing the meltwater and surface runoff to pond between the ice sheet and the Fort Wayne Moraine to the west (Fig. 5b). These dammed waters formed glacial Lake Maumee I, the predecessor of modern Lake Erie.

The ice-marginal Lake Maumee grew in size as the ice continued to melt toward the northeast. The overflow of Lake Maumee was channeled through the Fort Wayne outlet, which formed a low saddle in the Fort Wayne Moraine. These surplus waters were discharged by a short river flowing west into the Wabash Sluiceway (Fig. 5c). The Fort Wayne Outlet represents an exceedingly important development. It will receive detail treatment in the next section.

The recession of the ice deeper into the Erie Basin opened lower outlets that temporarily lowered Lake Maumee I. This initiated Lake Maumee II. The scattered remnants of the low beach has indicated that the latter was established at 760 feet above sea level.[12] A short readvance of the ice closed the other outlets; again the lake extended to the Fort Wayne Moraine.[13] This stage, Lake Maumee III, was established at 780 feet above sea level, nearly as high as Lake Maumee I. The Fort Wayne Outlet was then reactivated as the lake once again overflowed the mo-

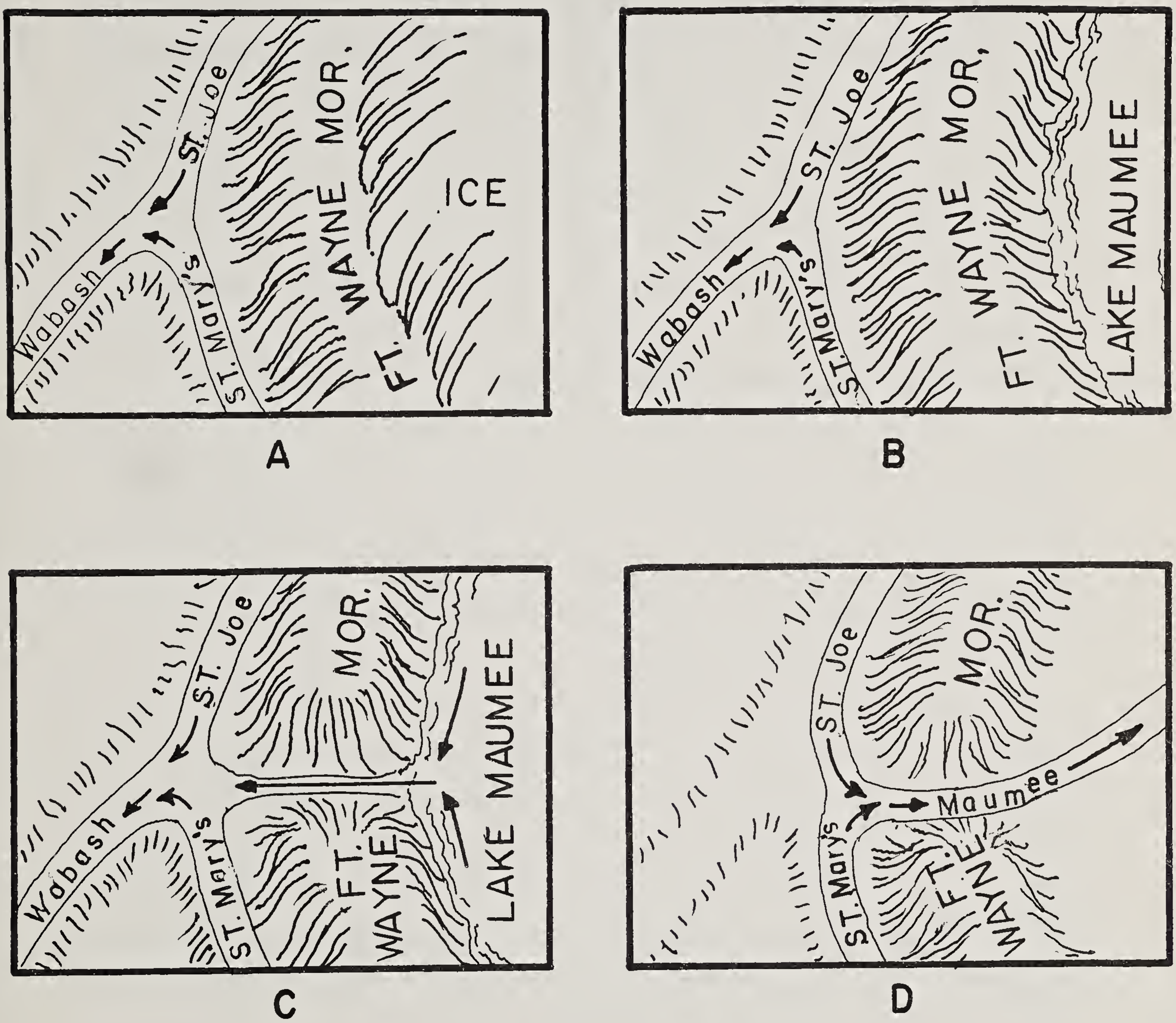


Fig. 5--Reversal Of The Maumee River.

raine dam.

When the lake level fluctuated, the Maumee River was formed, destroyed, and reformed. When the lake receded, the Wabash Sluiceway received less and less overflow until it carried only the surface runoff from the adjacent uplands. The St. Mary's and St. Joseph Rivers then joined and flowed eastward as the Maumee River through the abandoned spillway (Fig. 5d). At this stage the Maumee River was probably only a few miles long, extending from the junction of the two rivers which formed it to the shoreline of glacial Lake Maumee II near New Haven. Reactivation of the spillway during Lake Maumee III destroyed the Maumee River temporarily, but it was reestablished after the lake level dropped once again.

The initial stage, Lake Maumee I, was the highest for later stages moved into successively lower levels of the trough.[14] Lake Maumee I, the most active stage in Allen County, reached 790 feet above sea level. There is no evidence that Lake Maumee ever rose above that elevation.

The Maumee Plain, once part of the lake bottom, covers the east-central part of Allen County. It slopes to the northeast at approximately one foot per mile. The altitude of the plain at New Haven is 765 feet and at the Indiana-Ohio line is 750 feet. The edge of the plain is marked by former lake beaches that are indicated by the presence of ancient sand dunes, as well as by an abrupt change in slope and soil type.

In Allen County, Lake Maumee covered about 120 square miles including Maumee Township and parts of Adams, Jackson, Jefferson, Milan, St. Joseph, Scipio, and Springfield Townships. The Maumee lacustrine soils belong to the Lucas Catena and consist of calcareous clays and silts.[15] Most subsoils of the former lakebed have slow to very slow permeability, except for the river valley subsoils in the western

part which are very permeable.

Because of the flatness of the abandoned lake bottom and the relative impermeability of the clay till and stratified lacustrine sediments which cover it, the natural drainage is poor. The area once contained large tracts of swamp, but tiles and ditches now carry off the excess water.[16] Today, the area is excellent farmland and little trace exists of the former marshes.

V. THE WABASH SLUICEWAY

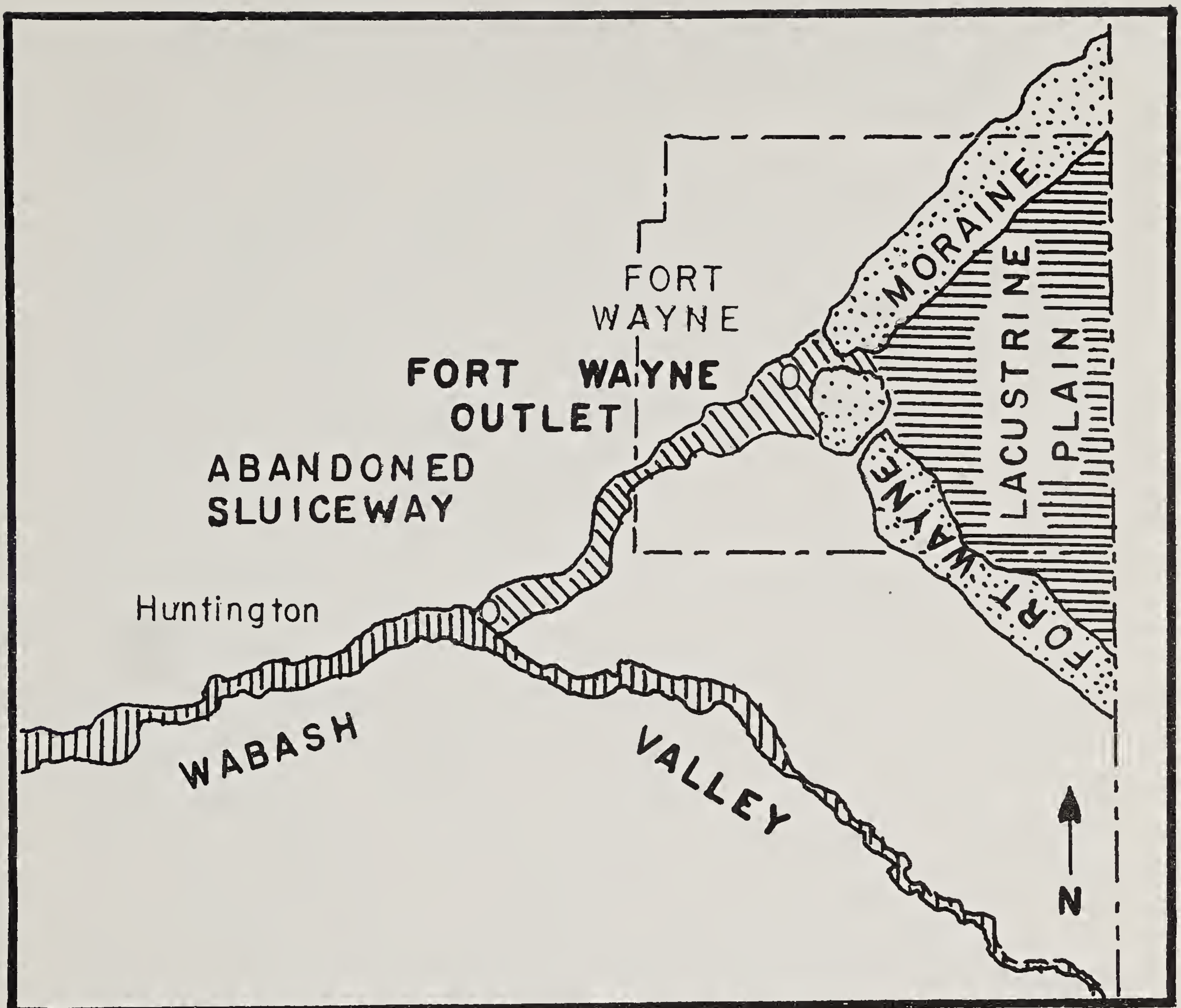
As the Erie Lobe of the Woodfordian Glacier retreated northeast toward the Erie Basin, its melt-water discharged to the southwest end of the trough where it joined the Wabash River. However, on formation of the Fort Wayne Moraine, water released by the melting ice could not enter the sluiceway and instead ponded to form Lake Maumee. The glacier continued to melt and the waters of Lake Maumee rose to a height sufficient to breach the moraine, resulting in the "Maumee Torrent."[17]

The gap in the moraine through which the escaping lake water flowed has been termed the Fort Wayne outlet. Actually, the waters broke through the moraine in two separate places only a few miles apart. The Fort Wayne Spillway was by far the most important of the two because of the huge volume it carried. The Trier Ditch Spillway (formerly known as Six-Mile Creek) was also significant.

The combined waters of the Fort Wayne and Trier Ditch Spillways, along with the waters of the St. Joseph and St. Mary's Rivers, flowed down the Wabash Sluiceway to join the Wabash River near Huntington (Fig. 6). The tremendous volume of the Maumee Torrent, which would compare with the present-day Mississippi, effectively eroded a broad, flat-bottomed channel in the valley fill of the Wabash Sluiceway. The Maumee Terrace which extends from Fort Wayne to the Lower Wabash Valley marks the former level of the torrent.[18]

The effects of the Maumee Torrent on the Wabash Sluiceway were so great that the magnitude was appreciated even by early geographers. In 1873 Newberry described the torrent in the following manner:

> A great river comparable with the Niagra



After Thornbury

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Fig. 6 -- Wabash Sluiceway.

> flowed from where Fort Wayne now stands, cutting a broad, deep valley through rock, sand, and gravel, and discharged into the Wabash. After flowing thus for ages, this river--which never had a name and which no man ever saw--ran dry and ceased to be, having been drawn to some other outlet.[19]

The Maumee Torrent did not flow for "ages" as Newberry suggested in his early report but was both intermittent and short-lived, lasting less than 1,000 years.[20] The torrent was not continuous because of fluctuations in Lake Maumee itself. Probably the greatest flow was during the stage of Lake Maumee I when the lake level was at its highest. Lower outlets opened and diverted the lake overflow from its course through the Fort Wayne Moraine.[21] When the climate cooled and ice once again blocked the other outlets of the lake, glacial Lake Maumee III rose high enough once again to spill through the gap. The outlet now deepened and widened by erosion carried about the same volume of water but the water level was not quite as high as in the first stage of the lake.

The Fort Wayne Spillway, shown in Fig. 7, begins approximately two miles west of New Haven where the northern and southern shores cease converging and turn west in parallel courses to form the bluffs of the stream. G.K. Gilbert noted the prolongation of the wings of the Van Wert Ridge (an upper lake beach) and was the first to suggest that they formed a channel through which the surplus waters of the lake were discharged to the southwest.[22] This gap in the moraine is about three-quarters of a mile wide, four miles long, and fifty feet deep at the present. It has been slightly deepened by postglacial stream erosion.

Once other outlets of Lake Maumee opened, the lake level dropped and the torrent ceased. However,

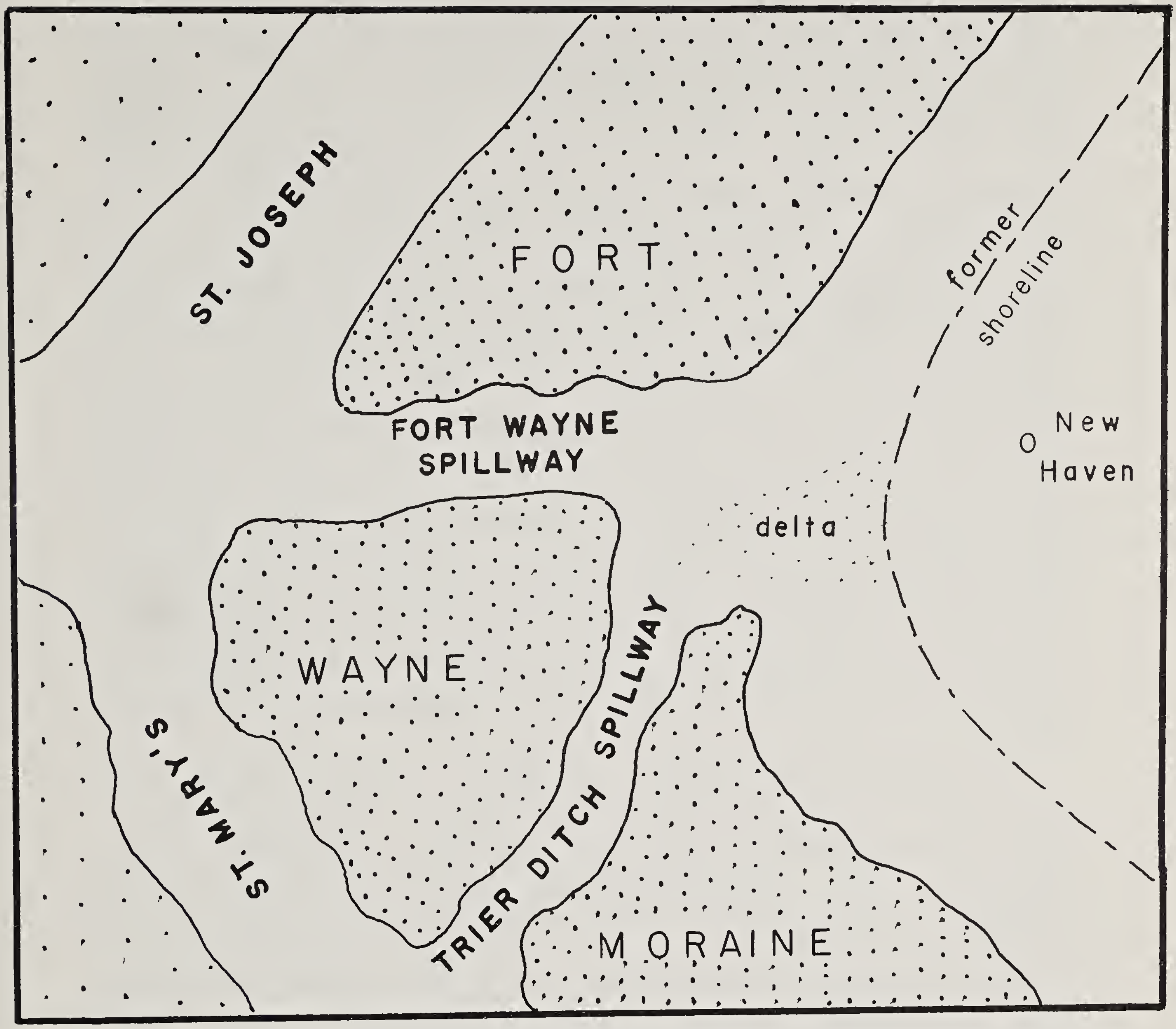
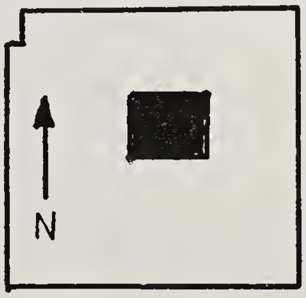


Fig. 7--Fort Wayne Outlet.



the excavation performed by the rushing water had lowered the gap in the moraine to a level that permitted the reversal of the Maumee River (Fig. 5). Before that time, the St. Mary's and the St. Joseph Rivers had flowed to the southwest into the Wabash because the Fort Wayne Moraine blocked their path to the Erie Basin. Once the gap was deepened by the torrent, though, the waters of the St. Joseph and the St. Mary's could once again follow the axial channel that slopes to the northeast by flowing through the abandoned spillway. These two rivers joined at the opening in the moraine to form the Maumee River, which flowed in a direction opposite that of the Maumee Torrent which had existed in the same channel only a short time before. Although the original drainage direction had been restored with the creation of the Maumee River, the tributaries were still forced to follow the border of the moraines resulting in a barbed pattern that reflects the glaciation of the region.

The Trier Ditch Spillway, shown in Fig. 7, was much smaller and represented a drainage alternative to the Fort Wayne Spillway six miles to the northwest. The Trier Ditch Spillway is only one-third as wide (one-quarter mile) as the Fort Wayne Spillway and the elevation of its floor is slightly higher than that of the larger spillway. Although the elevation of the Trier Ditch is forty to sixty feet below that of the surrounding moraine, its immediate banks are only fifteen feet above the stream bed. Since its summit is apparently a little higher than the second beach, it was probably not used as often as the other spillway.

There can be little doubt that Trier Ditch was formed by discharged waters from Lake Maumee rather than by normal stream dissection. The southern beach of the former lake turns up this channel on each side just as the western beaches did in the case

of the Fort Wayne Spillway. In a gravel pit along the east side of the recurved part of Trier Ditch, exposed bedding indicates that the channel was formed by a southward-flowing stream. Since the channel slopes to the north, it is unlikely that any activity short of a glacial torrent could have forced water through in a southerly direction.

Dryer has suggested that deposits of sand found near the north end of the channel may represent the delta of the St. Mary's River with Lake Maumee (Fig. 7).[23] When the spillway was inactive and while the St. Mary's was still carrying a great deal of water, there may have been a continuous flow to the northeast through Trier Ditch into Lake Maumee. Even today, during flood stage, waters from the St. Mary's flow through this channel to the Maumee in a short cut that bypasses the junction with the St. Joseph River. Thus the present flow (when a stream is present) is to the north, exactly opposite that of the Maumee Torrent that once poured through the spillway to the south.

The Fort Wayne and Trier Ditch Spillways constituted the head of the Wabash Sluiceway. The sluiceway itself, about thirty miles long, extended from the gap in the Fort Wayne Moraine to the Wabash River below Huntington. During its relatively brief existence, this sluiceway was the major tributary of the Wabash, and the effects of the torrent are noticeable far down that stream.[24] The fast-moving meltwater of the sluiceway carved in the valley fill a channel 60 to 100 feet deep and nearly 2 miles wide.

The small and insignificant underfit stream that occupies the sluiceway today would certainly have been incapable of such work. The overflow from Lake Maumee could have performed such a monumental task of erosion because the water had sufficient volume, had high velocity, and was relatively clear of sediments since Lake Maumee had acted as a settling

basin for all incoming outwash. Consequently, the torrent was able to trench the fill that had been deposited during earlier glaciations, cutting an erosional surface known as the Mississinewa Terrace twenty-five to thirty-five feet below the top of the fill.[25]

The bed of the Fort Wayne Outlet stands at 755 feet above sea level, or about 182 feet above Lake Erie, and that elevation is only about eleven feet less near Huntington and the junction with the Wabash. Only a glacial torrent would have had the force necessary to cut such a deep valley on such a flat plain. Shrock has even suggested that the floor of the sluiceway may be the old erosion surface of an upland peneplain antedating the glacial period.[26] Certainly, the till is not very thick there and the bed lies very close the bedrock. Valley-cutting in the sluiceway would probably have been more extensive if the gradient had been steeper.

The bluffs of the valley are quite distinct, and where the Wabash Moraine is bisected they rise 100 feet above the bed of the sluiceway. The bed itself is strewn with boulders and cobbles which would have required for transport more kinetic energy than any of the present streams currently possess. Parts of the bed were refilled, however, as the strength of the flow declined.

Because the gradient is so low and because the sluiceway does connect the Maumee and Wabash Rivers, a canal was built along this drainage line in the mid-1800's.[27] While the original canal was abandoned when overland transportation developed, there has been recent discussion of enlarging and reopening the canal to provide a link between the St. Lawrence Seaway and the Ohio River. The uncertainty in this proposal is whether or not there would be enough water to float ships of ocean-going size.

VI. OTHER DRAINAGE CHANGES

The reversals of Cedar Creek and the Maumee River are the most important drainage changes that have taken place in Allen County, but they are not the only ones. Several smaller streams show signs of having been diverted at one time, even though the present flow does not follow the diversion courses. In some areas the drainage is changing through integration as the waters of higher streams are pirated by lower ones. As those areas do become integrated, further diversions are likely to take place.

Numerous "relic" diversions indicate the temporary character of some drainage changes. When the ice field was present, many streams found alternate channels since their natural courses were blocked by the glacier. When the ice withdrew, these streams resumed their former routes and abandoned the temporary channels. In the northwestern and southeastern parts of the county, these courses are especially noticeable.

Integration of drainage has been largely responsible for the gradual disappearance of morainal lakes in Allen County. At the close of the deglaciation, lakes known as "kettle holes," formed by ice blocks left behind in the till were numerous in the morainal part of the county. Now there are only two kettle lakes of any significance, White Lake and Lake Everett (Fig. 8), and their size is much reduced. They have been destroyed largely by the establishment of drainage lines to lower elevations which have allowed much of the lakewater to be carried off. As the drainage lines become more integrated, their ability to drain the lakes increases while the lakes get smaller.[28] Before it was drained by a tributary of the Eel River, Lake Everett was nearly two miles wide and exceeded three miles in length; White Lake was nearly

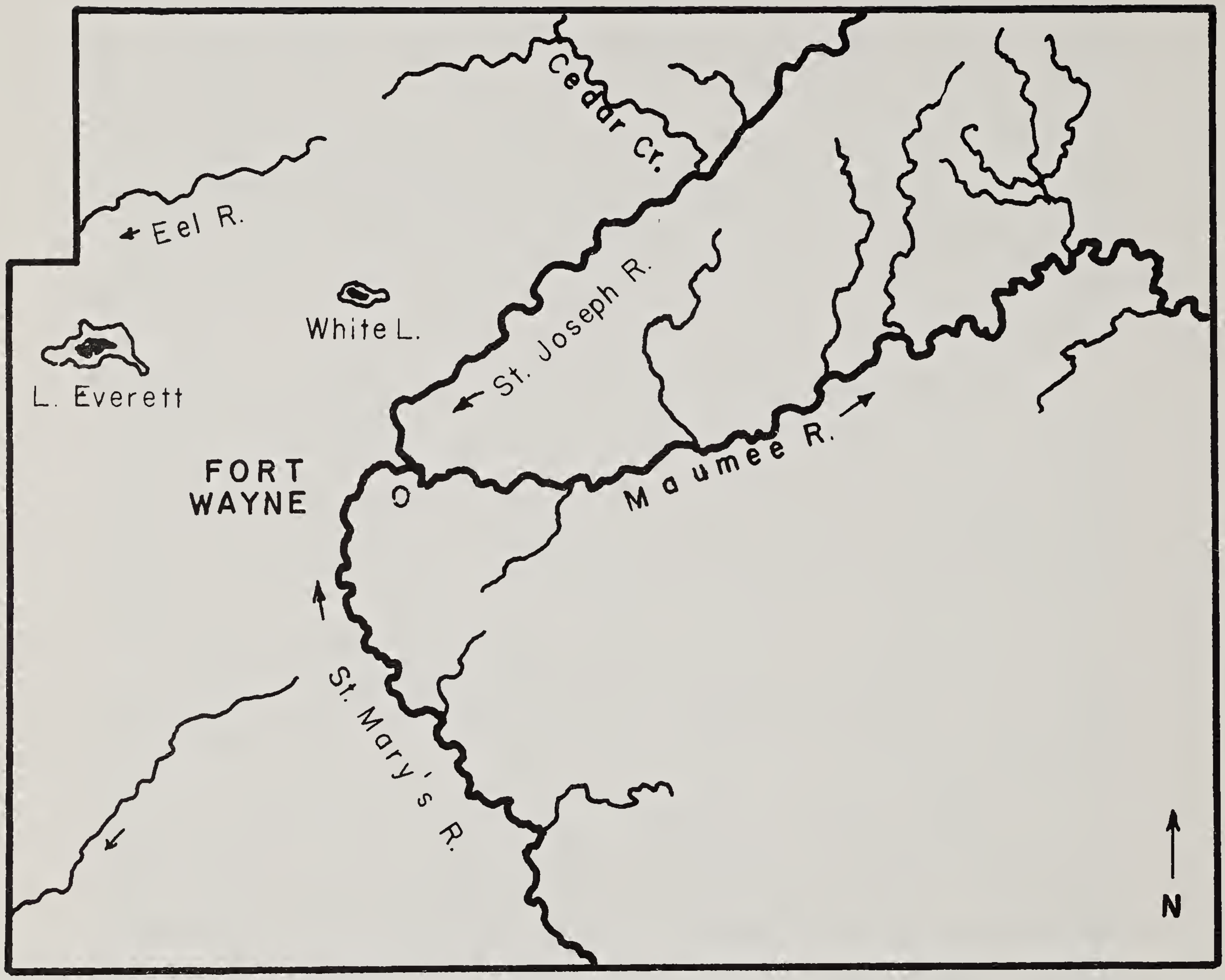


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Fig. 8--Present Drainage Pattern of Allen County.

as large. Today, these lakes are much smaller, about one-half mile wide and one-half mile long, and most of this reduction has been due to integration which is still not complete. Some of this loss of size may be due to artesian drainage which feeds wells on the till plain, and some may be due to lake-filling by sediments and organic material.

VII. PRESENT DRAINAGE PATTERN

The drainage pattern of Allen County has gone through several distinct phases since the beginning of the Pleistocene. The drainage before the Pleistocene was most likely dendritic since it had developed on an old erosion surface which would have offered few topographic barriers to such a network. The pattern during the Pleistocene was glacially-disrupted, since the meltwater flowed over the freshly-laid till in undefined channels. Immediately following the withdrawal of the ice from the county, the drainage was subdendritic because Maumee lakewater flowed down the Wabash Sluiceway, and the position of the moraines did not interfere with flow in that direction. However, the lowering of the level of Lake Maumee restored, the drainage divide opened lower stream courses. Therefore, when the Maumee River reversed and began flowing into the Erie Basin, the present barbed drainage pattern (Fig. 8) was established.

The tributaries of the Maumee have been forced to follow the borders of the moraines and consequently join the trunk stream at obtuse angles. All of the major tributaries on the Erie side of the drainage divide turn back upon themselves as they join the Maumee. The St. Joseph is especially affected by its marginal position on the Fort Wayne Moraine, and in less than 10 miles its waters are turned through an angle of 160 degrees before joining the Maumee. The junction angle of the St. Mary's is nearly as great, being on the order of 140 degrees. The result is a barbed pattern which Parvis calls "calcarate"[29] or "spurred" and which Dryer terms "sagittate."[30]

All of the streams in the county are of the superposed variety and most have entrenched themselves in the till plain. Former sluiceways like the St. Joseph have cut noticeable terraces, but the more recent

rivers like the Maumee have cut none. Because they do follow the moraine so closely, the drainage basins of the St. Joseph and St. Mary's lie almost entirely upon the western sides. Very little area is drained to the right of either the St. Joseph or the St. Mary's and those streams are far from being centered in their drainage basins. At one point, the divide on the east is only three miles from the St. Joseph River, while the divide on the west is nearly twenty miles from the same river.

One striking aspect of this pattern is that the smaller streams which follow the slope of the trough, often flow in a direction approximately ninety degrees away from the main streams which skirt the moraine. The St. Joseph River, for example, flows to the southwest, but nearly all of the streams in its drainage basin flow to the southeast (Fig. 8). The small streams constitute a dense network on the moraines and their drainage pattern alone is sufficient to distinguish the moraines from the surrounding plain.

SUMMARY

The glaciers that passed over Allen County left traces of their existence in the form of glacial features and stream diversions. The drainage pattern is completely different from what it was before the glaciation, although the major drainage divide is in nearly the same location. That some water is shed into the Erie Basin and some into the Wabash Basin has little to do with the preglacial divide. The original divide had been bedrock, but the present one had developed in moraine and outwash sediments. All of the streams in the county are superposed and most have trenched their valleys to some extent.

The greatest changes occurred when the ice withdrew. When the retreating ice exposed the channel of the St. Joseph, Cedar Creek was diverted away from the Eel Sluiceway, which finally silted up. Cedar Creek now flows in a direction exactly the reverse of that it took as a preglacial stream.

An even more important reversal took place at the Fort Wayne Outlet of Lake Maumee. Glacial Lake Maumee once covered the east-central third of the county and was dammed by the crescentic Fort Wayne Moraine. Overflow from the lake channeled a gap in the moraine, creating the "Maumee Torrent." Although it existed for only a brief time this torrent was one of the world's greatest rivers in terms of volume. The escaping water excavated the Wabash Sluiceway which connects Fort Wayne and Huntington, but the torrent ceased and the sluiceway went dry when the level of Lake Maumee dropped. Once the torrent stopped and the lake no longer occupied that part of the trough, the Maumee River formed and reversed the direction of flow back toward Lake Erie.

The barbed drainage pattern of Allen County is a consequence of the position of the moraines relative

to the trough. These parallel crescentic ridges were left by the receding ice sheet and lie across the axis of the trough. The axial channel (Maumee River) is undisturbed, but its tributaries are forced to follow the borders of the moraines for some distance before meeting the trunk stream. These deflections result in nearly all of the major tributaries joining the main stream at obtuse angles.

FOOTNOTES

1. William J. Wayne, "Thickness of Drift and Bedrock Physiography North of the Wisconsin Glacial Boundary," _Indiana Geological Survey Report of Progress No. 7_ (Bloomington: Indiana Geological Survey, 1956), p. 32.

2. William J. Wayne, personal communication.

3. Wayne, "Thickness of Drift and Bedrock Physiography North of the Wisconsin Glacial Boundary," p. 41.

4. _Ibid._, p. 35.

5. William D. Thornbury, "The Geomorphic History of the Upper Wabash Valley," _American Journal of Science_, 256 (Summer, 1958), p. 459.

6. Thornbury, "The Geomorphic History of the Upper Wabash Valley," p. 459.

7. Wayne, "Thickness of Drift and Bedrock Physiography North of the Wisconsin Glacial Boundary," supplemental map.

8. Frank Leverett, _The Pleistocene of Indiana and Michigan_, USGS Monograph No. 53 (Washington, D.C.: U.S. Government Printing Office, 1915), pp. 171-172.

9. Merle Parvis, "Atlas of County Drainage Maps, Indiana," _Purdue University Engineering Bulletin_, XCVII, (July, 1959), p. 3.

10. Grove Karl Gilbert, _Surface Geology of the Maumee Valley_, (Columbus: Geological Survey of Ohio, 1873), p. 572.

11. N.H. Winchell, _Proceedings of the American Association for the Advancement of Science for 1872_ (New York: American Association for the Advancement of Science, 1873), p. 152.

12. Richard F. Flint, _Glacial and Pleistocene Geology_ (New York: Wiley, 1957), p. 343.

13. Leverett, *Glacial Formations and Drainage Features of the Erie and Ohio Basins,* p. 711.

14. Flint, *Glacial and Pleistocene Geology,* p. 343.

15. Parvis, "Atlas of County Drainage Maps, Indiana," p. 3.

16. Charles R. Dryer, "Report Upon the Geology of Allen County," *Indiana Department of Geology and Natural History 16th Annual Report* (Indianapolis: Indiana State Printing Office, 1889), p. 108.

17. Thornbury, "The Geomorphic History of the Upper Wabash Valley," p. 465.

18. M.M. Fidlar, "Physiography of the Lower Wabash Valley," *Indiana Department of Conservation Bulletin,* II (1948), pp. 71-72.

19. P. Newberry, *Fort Wayne Gazette,* Dec. 5, 1873, p. 5.

20. Flint, *Glacial and Pleistocene Geology,* p. 343.

21. J.L. Hough, *Geology of the Great Lakes* (Urbana: University of Illinois Press, 1958), p. 141.

22. Gilbert, *Surface Geology of the Maumee Valley,* p. 572.

23. Dryer, "Report Upon the Geology of Allen County," p. 15.

24. Thornbury, "The Geomorphic History of the Upper Wabash Valley," p. 466.

25. Thornbury, "The Geomorphic History of the Upper Wabash Valley," p. 465.

26. Robert R. Shrock, "Some Interesting Physiographic Features of the Upper Wabash Drainage Basin in Indiana," *Proceedings of the Indiana Academy of Science* (Indianapolis, Indiana, 1928), p. 127.

27. Charles R. Dryer, "The Maumee-Wabash Waterway," *Annals of the Association of American Geographers,* IX (March, 1920), pp. 47-49.

28. Robert E. Horton, "Erosional Develop-

ment of Streams and Their Drainage Basins: Hydrophysical Approach to Quantitative Morphology," Bulletin of the Geological Society of America, LVI (March, 1945), p. 335.

29. Merle Parvis, "Drainage Pattern Significance in Airphoto Identification of Soils and Bedrocks," Photogrammetric Engineering, XVI (1950), p. 393.

30. Dryer, "Report Upon the Geology of Allen County," p. 106.

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